
JOURNAL
OF THE
ARNOLD ARBORETUM

VOL. XXIX

JULY 1948

NUMBER 3

DISTRIBUTION AND OCCURRENCE OF WHITE PINE (*PINUS STROBUS* L.) AND RED PINE (*PINUS RESINOSA* AIT.) AT THE NORTHERN LIMIT OF THEIR RANGE IN ONTARIO

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With three plates

INTRODUCTION

IT IS MORE THAN FIFTY YEARS since Robert Bell published the last of his several papers (2, 3, 4) on the distribution of forest trees in eastern Canada, and laid down on a map his final representation of the northern limits of the principal species east of the Rocky Mountains.¹ In the interim, knowledge and understanding of the forests of eastern Canada have been greatly advanced, thanks to exploration and the progress of research in several fields; but little has been added in the literature to what Bell said concerning the actual geographical distribution of forest trees, especially at the northern limits of range.² His work in that field remains the principal source to which are indebted the authors of standard and popular works published since the beginning of the century.

* The author has compiled a check list of stations for white pine and red pine at the northern limit of their range in Ontario, published in 1948 and cited as (12) in the bibliography accompanying the present paper. Through the kindness of the Ontario Department of Lands and Forests, separates of the check list are available and will be mailed to subscribers to the Journal of the Arnold Arboretum.

¹ Bell's first contribution was a map, the first of its kind in Canada, which showed the northern limits of the principal timber trees in the original Canadian provinces. That map was published in 1879 under the authorship of A. T. Drummond (6); but according to the latter is attributable to Bell and Drummond jointly. According to Bell (4) it was drawn originally by him in 1873. It was used by the Canadian Department of Public Works in the preparation of the first official tree range map in Canada.

² Reference is made to the presentation of authentic distributional data. In 1905 Transeau (14) showed on a map, by means of varying depth of shading, the extent and overlapping of the ranges of several conifers in the northeast, but he did not record any new stations. Later (15) he illustrated the ranges of red and white pine on

Was Bell's work truly exhaustive? No great change could be made in the position of the tree lines on his map. His account of isolated and rare occurrences of several species, remarkable in itself, remains of interest and value to-day, — the more so since some of the stations described have already disappeared, and others are threatened by exploitation. But Bell recognized that his account of distribution was far from complete in detail, and that his map might even be misleading in part. Thus he said that the tree lines were "general boundaries," and that occasional or "chance" trees were known to occur beyond them. Again, he remarked on the extraordinary scarcity of stations at some places within the lines, and expressed doubt as to where the boundary should be placed. In thus picturing the broad configuration of the northern limits of distribution, the true character of the boundary zone was not represented. That character is of prime importance and is highly significant in the interpretation of vegetation dynamically.

In the course of exploration and development of the country since the beginning of the century, many new and relevant observations of tree occurrences have been made, which together comprise an important body of distributional data. These for the most part have failed to find their way into print, or have remained isolated and inaccessible, without benefit to the literature of forest geography. A notable contribution, however, was made by Halliday and Brown (8), who introduced new data and employed a novel method of illustrating the distribution of some of the principal Canadian forest trees. One of their aims was to show the relative importance (abundance) of each species throughout its range. For that purpose population density class maps were prepared from a large body of timber cruise data; but having few for red and white pine deemed suitable for their purpose, those species were not dealt with.

That omission was doubtless warranted, for exploitation over a period of two hundred years has greatly modified the natural distribution of red small maps by means of dots; but for northern Ontario his representation was purely conventional. In detailed studies in Ontario relating to distribution, Hutchinson (9) did not present new geographical knowledge. His tree lines were essentially those of Bell. Sudworth (13), in his atlas covering *Pinus*, showed the distribution of each species by a field of solid colour. In a commentary, Fernow (7) criticized the "scalped outline on the outskirts" of the field representing the distribution of white pine, and queried whether certain discontinuous parts were truly representative, or merely suggestive. Moreover, he stated that ". . . what is really much more needed, and would prove of exceeding value, is the detail distribution on a large scale map, even if it were of only a limited number of species, and especially of their outskirts, when the ecology of the species could be brought out with more satisfaction." In 1938 Munns (11) prepared distribution maps after the manner of Sudworth, by compiling "reliable information from many sources," published and unpublished. For red and white pine, which were pictured separately, the northern limits in Ontario were approximately as shown in the Dominion government atlas maps published in 1906 and 1915. These had departed slightly from Bell's map in showing red pine farther north than white pine, as had been suggested in Bell's text. In 1941 the Ontario Department of Lands and Forests published an atlas containing a map showing tree lines in the province (1). Recently a compilation of the data which are the basis of the present study was issued by the same service (12).

and white pine quantitatively throughout a large part of the range of those species. Their northern limits in Ontario, however, have remained comparatively undisturbed until recently; and for the parts where logging has encroached there, data representing virgin conditions are available.

Actually red and white pine offer peculiar advantages for distributional study. Their large size renders them comparatively conspicuous in the northern forest. Moreover their commercial value has been the cause of their being reported carefully and regularly in explorations and surveys under government supervision from the earliest days to the present time.

In view of the above it seemed both appropriate and feasible to undertake a detailed investigation of the distribution of red and white pine at the northern limit of their range. The following pages comprise the results of such study in the province of Ontario.

METHOD AND SOURCES

Common knowledge suggested the preliminary definition of a base line or datum beyond which the occurrence of red and white pine might be taken to be local, sporadic, or rare. That line was chosen as follows:— From the Quebec boundary westward along the height of land between the St. Lawrence and James Bay waters to the height of land portage on the Michipicoten–Missinaibi route to Moose Factory; thence southwesterly along that route to Michipicoten and westerly along the shore of Lake Superior to the head of Black Bay; thence along the north boundary of the township of Dorion and its projection due west through Dog Lake to the Canadian National railway, and along that line through Sioux Lookout and Kenora to the Manitoba boundary.

All reliable records of occurrence of white or red pine north of that line known to the writer have been assembled elsewhere (12), and are plotted on the maps herewith. For these data I am indebted principally to the reports of land surveyors, who, since the beginning of government administration in Ontario, have carried out explorations, meridian and base line surveys, township subdivisions and lake and river traverses on the Crown lands. As already indicated, in the course of that work they regularly described the forest conditions, and in particular noted the occurrence of red and white pine timber. To their reports have been added unpublished records derived from personal observation and information received from correspondents. For the latter I am indebted chiefly to associates in the Department of Lands and Forests, especially to Messrs. J. Barron, R. Boulton, J. A. Brodie, W. D. Cram, Q. Hess, H. Hills, T. E. Mackey, W. J. Robinson, J. Ruxton, R. Taylor, and B. Wilson.

In assembling the records and in plotting them, it was necessary to distinguish “stands” from “scattered trees,” and from “single” or “isolated” trees. Admittedly the distinction between those classes was not always an easy one to make. In general a “stand” represents a community (*Pinetum*), while “scattered trees” represents occurrence where from the

station occupied by the observer, several to many widely separated individual trees could be seen. Some of those trees may have been virtually isolated. "Single" or "isolated" occurrences are those where one, or not more than seven trees in a group were found remote from other specimens. Veritable single tree occurrences, of which a number are known, are recorded elsewhere (12).

For the most part these reports antedate forest exploitation in the regions concerned. The picture of distribution given may be taken therefore as representing virgin conditions.

DISCUSSION

Occurrences of white and red pine north of a line already described are plotted on maps herewith. The actual distribution of those species there is seen to be referable to eastern and western sectors, the region north of the central part of Lake Superior being virtually without occurrences. The few known stations for red pine there are rightly regarded as isolated and quite exceptional.

In the western sector both red and white pine range considerably farther north than in the east. There, too, in the peripheral zone as generally, red pine is much commoner than white pine; while in the east (and in the Nipigon area) the reverse is true. The relative abundance of red pine increases toward the north throughout.

The general configuration of the northern limit of distribution parallels the yearly isotherms and is related to the length of frost-free period. Thus the region to the north of Lake Superior, which is apparently not unfavourable for pine edaphically, has a shorter frost-free season than contiguous areas to the east and west. Similarly, in the sector outlined by the limit of pine west of Lake Superior, spring comes two weeks earlier than farther north and east.

Within the selected border zone pine is almost everywhere sporadic or rare; but its frequency of occurrence varies in different parts, as can be shown quantitatively. If by "occurrence of pine" is meant the report of occurrence, whether of stand, scattered trees or single trees, the rate of occurrence per thousand square miles may be stated approximately for different regions as follows:

<i>Region</i>	<i>Rate of occurrence of pine per 1000 square miles</i>
District of Sudbury north of the height of land	22
Districts of Temiskaming and Cochrane north of the height of land as far north as town of Cochrane	8
District of Algoma north of Michipicoten	5
Territory west of Lake Nipigon north of a selected line	3

The above frequencies indicate that isolation and disjunction, increasingly significant toward the north, characterize the distribution of white and red pine throughout the whole of the area considered. The depth of the zone in which pine is sporadic or rare is generally more than one hundred miles.

In the east the principal concentrations of pine north of the height of land were originally in the area bordering Lake Mattagami and the parallel waters of Grassy River, including Kapiskong, Nursey, and Sinclair Lakes. That country was referred to in a general way by Cavana and Watson in 1911 as "a locality eminently suited to the growth of red and white pine, but this timber is not greatly in evidence." It continues to supply to this day, however, some pine logs for the mills at Timmins.

There is also a noteworthy concentration of pine in scattered stands in the vicinity of Horwood Lake, some of which remains. That region was described by Speight and van Nostrand in 1907 as "the most promising for white and red pine that we have seen in the James Bay watershed."

The township of Frater, too, originally contained a considerable amount of red and white pine timber. Farther west, fires have possibly obliterated evidence of pines in historical times; but the known occurrence of scattered veterans in the country north of Chapleau suggests a former concentration there. Similarly, pine occurrence is indicated west of Missinaibi, in the vicinity of Manitowick Lake, though few trees remain there now.

A few noteworthy stands of red pine are known even farther north in the district of Algoma. A well known one on the portage from Oba River to Kabinakagami Lake, in Derry Township, which was first reported by Baird in 1900, still remains. But that one which formerly stood where the railway now crosses the Kabinakagami River is gone completely. It furnished convenient piling for the numerous trestles built during railway construction.

On the Nipigon drainage, a considerable amount of pine has been cut, and some remains. One of the principal stands was possibly that which formerly stood in the vicinity of Pine portage on the Nipigon River, which was described by Herrick in 1860. Other concentrations occurred in Innes Township, where until recently red pine stood on the shore of Lake Nipigon. Around Kabitotikwia and Black Sturgeon Lakes, remnants of once fairly extensive stands, principally of white pine, can still be found.

In the peripheral zone west of Lake Nipigon, it is scarcely possible to recognize concentrations of pine. Occurrences of both species are extremely rare and widely scattered. There are stations for white pine on Sturgeon Lake, lac Seul, Pakwash and Red Lakes; and for red pine on Savant Lake, Lake St. Joseph, Red Lake and Nungesser Lake. Perhaps the chief centre for white pine was around the west end of Sturgeon Lake. Both species are scattered here and there on the shores and islands of the central part of lac Seul. The largest stand of red pine is on Thaddeus Lake, near lac Seul.

In the northern clay belt area, the principal concentration of white pine (with considerable red pine, too) was undoubtedly that which formerly covered the sand hills in Dundonald and Evelyn Townships, near Frederickhouse Lake. A smaller stand of fine quality occurred in the township of Edwards some distance to the northeast. The principal stand of red

pine, long since cut, was at the outlet of Abitibi Lake, in the township of Kerrs. There was formerly a small stand of red pine on a point of land extending into a lake near the central part of Alexandra Township. A remarkable grove, the most northerly known in these parts, still stands on the shore of Lake Montreuil in Swartman Township.

Although white and red pine are already comparatively rare and of sporadic occurrence in the forest some distance south of the northern clay belt, they are found much less frequently once that area is entered. Yet it is noteworthy that both species penetrate it deeply and are found at widely scattered stations where soil conditions are favourable. In the Temiskaming clay belt, however, pine was originally much commoner than in the northern one.

Within the so-called clay belt areas, the extensive clay and silt deposits are generally unsuitable for the growth of pine, especially as compared with spruce, with which it must compete. When pine occurs it is found on sandy or gravelly deposits, on rocky hills or on occasional rocky shores of lakes and rivers, and on islands. The deep extensive morainic deposits in Dundonald and Evelyn Townships must have stood as islands in glacial Lake Ojibway. Smaller deposits, evidently of fluvio-glacial origin, appear to have been water-washed to sandy and gravelly bars of scarcely perceptible elevation. On such sites both red and white pine have been found. For the most part, however, red pine occurs on the coarser gravels of eskers and kames, especially where they protrude as sharp points or hog's backs into lakes.

The two species differ considerably in their sociability. Red pine is usually gregarious, even at the extreme limit of its range. The stands, however, are small, often comprising only a few acres or less. They usually appear to be roughly even aged, though poles, saplings and smaller trees are not unknown, especially at the margins of mature groves. In the case of white pine, occurrence is typically "scattered" or "scattering" — adjectives that recur in the field notes with monotonous frequency. Such trees are often virtually isolated individually, and certainly do not any longer represent a pine community. Usually large and overmature, though cones are borne from time to time, they are not replaced when they fall. That such trees sometimes represent a former pinery is evident from the presence of stubs and fallen timber in various stages of decay. The approximate even age of the timber left suggests, too, a common origin for all.

Scarcity of young pines, especially white pine, is strikingly characteristic throughout the northern boundary zone. While it is probably true that observation and reporting have not been as satisfactory for small trees as for large ones, the reports undoubtedly reflect an actual dearth of reproduction. Young trees, which were taken as trees reported in the notes as young, small, or less than twelve inches in diameter, were noted only twenty-five times in a total of three hundred and seventy-one pine observations.

That white pine formerly occupied areas where it is now entirely absent is evident from some early survey reports. According to McAree, the township of Homer, in the district of Thunder Bay, contained no standing pine when he surveyed it in 1872; but he said that charred stumps of white pine and cedar of large size were all through the woods, the country having been burned over fifty or sixty years earlier. Similarly, McAuslan and Anderson, reporting on Nassau and Storey Townships in 1915, found no pine there at that time, but said that much of the land had formerly been timbered with cedar and white pine, which had been destroyed by fire and succeeded by spruce. A few scattered specimens of white pine still standing in Langemarck and Dowsley Townships, and the two single trees recently found in Rogers and Studholme Townships, are possibly remnants of a once extensive forest in which that species was well represented. Again, there is at least the suggestion that white pine (or possibly red pine) formerly occurred in Chipman and O'Meara Townships northeast of Longlac. The lake in those townships shown on map No. 23a Province of Ontario, as "Chipman Lake" was formerly known locally as "Pine Lake" and was thus marked on a map published by the Crown Lands Department in 1901. The reference would hardly be to jack pine. Attention may be drawn here to Bell's report of stories to the effect that white pine once extended considerably farther north along the principal tributaries of the Moose, but that it had been destroyed by fire there and was succeeded by other species.

This picture of actual distribution suggests decadence and retreat. Isolation is evidently acting here against reproduction, and therefore as a barrier to migration. For these scattered trees are almost certainly self-fertilized, which for white pine results in seedlings of comparatively low vigour; and for red pine in a reduction of the amount of seed set, as shown experimentally by Johnston (10). These handicaps contribute to failure in competition with other species, to which white pine especially is exposed.

On the other hand it cannot be denied that some few white pines have grown as isolated pioneers in new localities. Thus a single tree, now gone, which formerly stood on an island in the Mattagami River in Harmon Township, was almost certainly a pioneer from seed brought with flood wood from the headwaters of the river. Standing twenty miles from its nearest neighbors (a group of five old pines on another watershed, themselves thirty miles or more from any other known station) it is significant, perhaps, that the tree failed to reproduce itself. The extraordinarily rare occurrence of three young white pines, some twenty feet high, on top of a rocky bluff overlooking Penelton Lake in Opazatika Township, is harder to account for.

It is of interest to speculate on the origin of the forest biota populating the zone in which red and white pine now find their northern limit. From what source or sources have they been derived, and what has been the direction and chronology of migratory movement? It is evident that the

concept of migration from remote refugia is valid only in its broadest application. The evolution of the glacial lakes precluded the possibility of a uniform advance in the wake of the ice; — water coverage has played a role no less important than ice coverage, locally, in the history of re-vegetation in northern Ontario. Thus the western area of the province, except below the level of Lake Agassiz, has been exposed throughout the relatively long period of Algonquin time, and subsequently. On the other hand, farther east Algonquin waters covered most of the present "compact" area of pine distribution in the upper lakes drainage in Ontario until comparatively recently. But the surface of Lake Algonquin was not uninterrupted. Besides the great Pukasaw promontory which Coleman (5) thought was exposed, large land masses to the east, well over 1500 feet above sea-level, must have stood as islands in the lake. The largest of them, an area of some twelve hundred square miles, centres on the upper waters of the Mississagi River. Another highland area of some two hundred and fifty square miles lies at the headwaters of the Montreal and Chapleau Rivers. These and smaller areas were well situated to reforest the bed of Lake Algonquin as the waters receded to the Nipissing Great Lakes levels. That forests existed on the north shore of Algonquin can scarcely be doubted. Their character is suggested by the deposits of flood wood that Coleman (5) found near Michipicoten, which he said were probably of Algonquin age, and certainly older than the Nipissing Lakes. They contained trunks recognized as poplar, cedar, balsam, white and black spruce, jack pine and white pine.

SUMMARY

This study is based on a summary report and analysis of all the records known to the writer of the occurrence of white and red pine north of a specified line in Ontario (12). It comprises a map showing the location and character of the stations, and a discussion of the actual distribution and mode of occurrence of those species at the northern limits of their range in the province.

The base line selected was the height of land between the Great Lakes and James Bay from the Quebec boundary westerly to a point near Missinaibi; thence to Lake Superior at Michipicoten and along the shore to the head of Black Bay; thence westerly to the Canadian National railway and along that line to Sioux Lookout and the Manitoba boundary.

The distribution of white and red pine north of that line is seen to be referable to eastern and western sectors. In the region north of the central part of Lake Superior stations for white pine are unknown, and red pine is exceedingly rare. In the western zone red pine is commoner than white pine, while in the east and in the Nipigon area the reverse is true. The relative abundance of red pine increases toward the north throughout.

Red pine occurs typically in small stands on the coarser glacial deposits; white pine is usually scattered and is less selective with respect to site. Reproduction is exceedingly scarce, especially in the case of white pine.

The depth of the peripheral zone, in which white and red pine are sporadic or rare, appears to be generally more than one hundred miles. Within that zone many stations are virtually isolated and self pollination of the trees must be the rule. Early survey reports record the occurrence of pine at stations where it is now absent. The present condition of many white pine stands suggests that they are decadent.

The history of the glacial lakes in northern Ontario has been of prime significance relative to the actual distribution and age of the forests there. Highland areas, available for colonization at a relatively early date, have been forested much longer than the areas covered by the waters of Lakes Algonquin and Ojibway, and have doubtless contributed to the vegetation of the latter.

ACKNOWLEDGMENT

This study was supported by the Department of Lands and Forests, Province of Ontario. The writer is especially indebted to the office of the Surveyor General for access to survey records and for the preparation of map figures, and to correspondents named in the text who provided personal information.

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EXPLANATION OF PLATES I, II, AND III

Distribution of white pine and red pine at the northern limit of their range in Ontario. Eastern, central, and western parts respectively. Scale: 48 miles = 1 inch.

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